Fig. 1

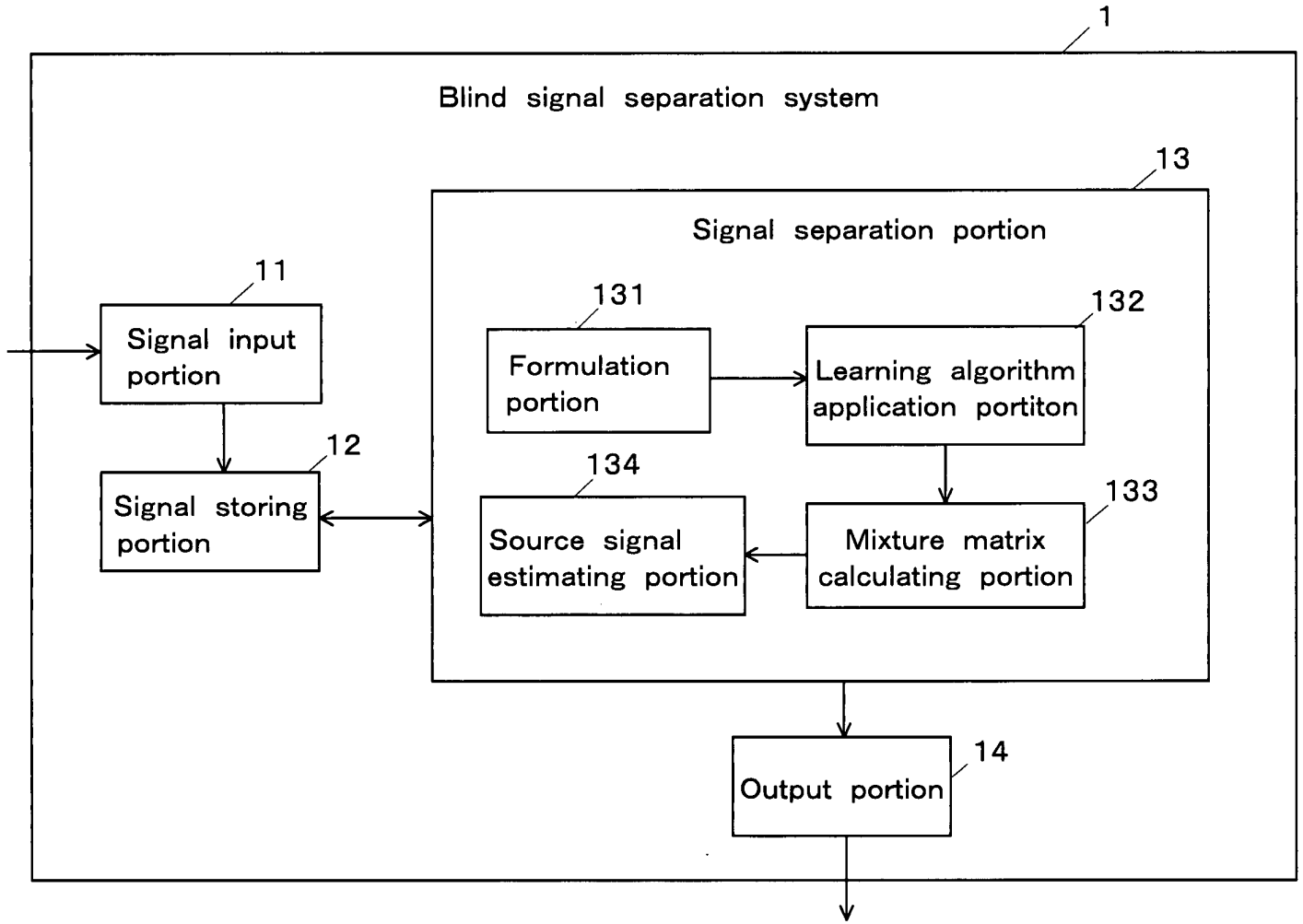
1
Blind signal separation system
13
Signal separation portion
11
Signal input portion
131
Formulation portion
132
Learning algorithm application portiton
12
Signal storing portion
134
Source signal estimating portion
133
Mixture matrix calculating portion
14
Output portion

Fig. 2

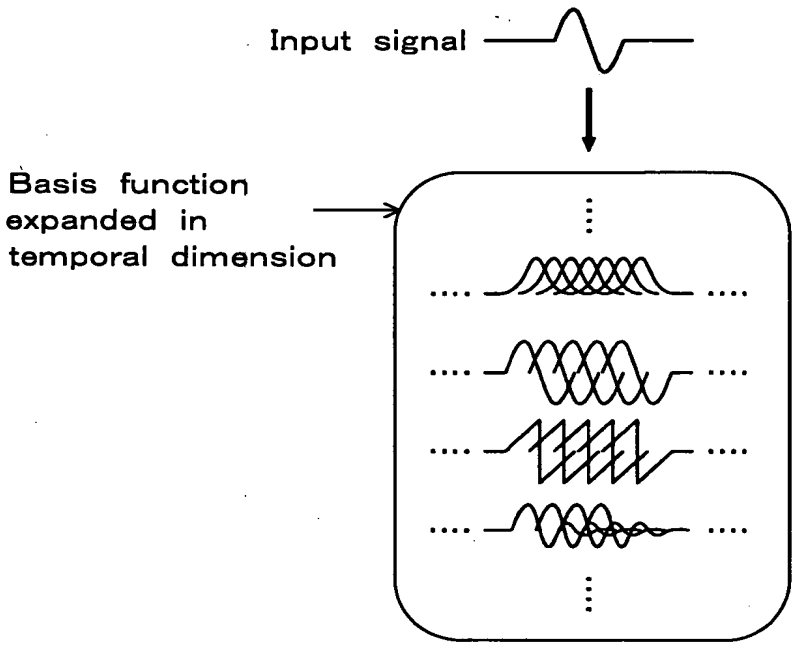
Input signal
Basis function
expanded in
temporal dimension

Fig. 3

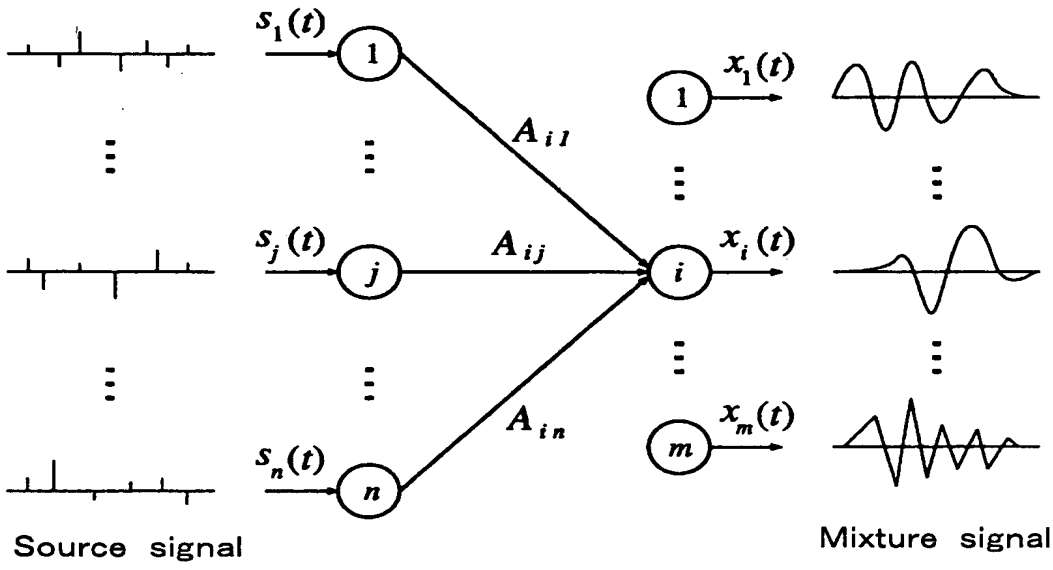
$s_1(t)$
1
$s_j(t)$
j
$s_n(t)$
n
A_{i1}
A_{ij}
A_{in}
1
$x_1(t)$
i
$x_i(t)$
m
$x_m(t)$
Source signal
Mixture signal

Fig. 4

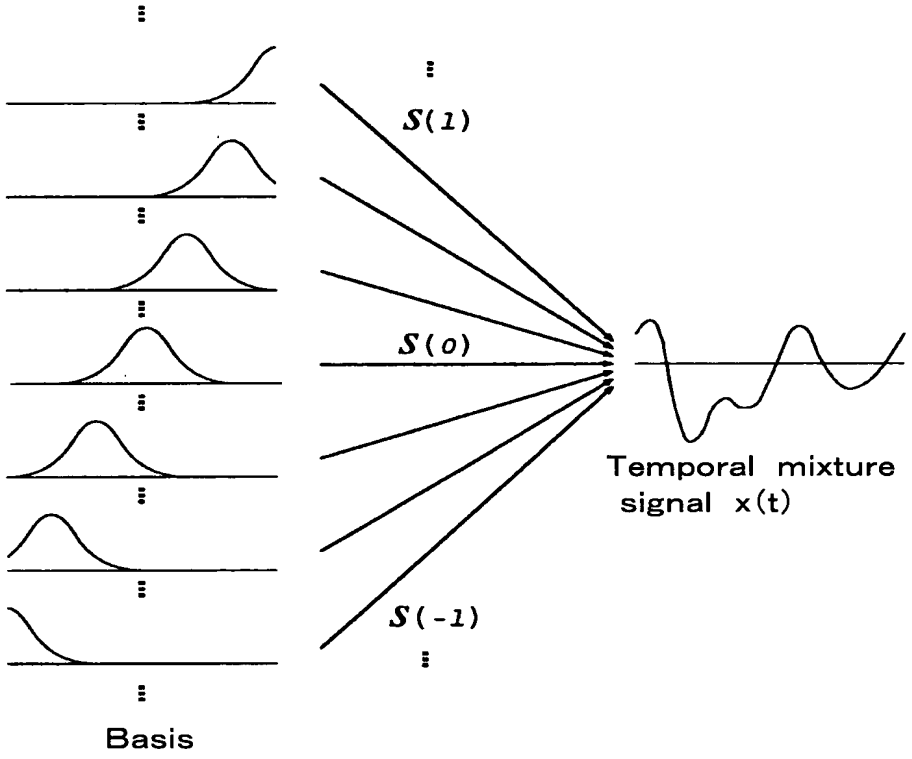
S(1)
S(0)
S(-1)
Temporal mixture signal x(t)
Basis

Fig. 5

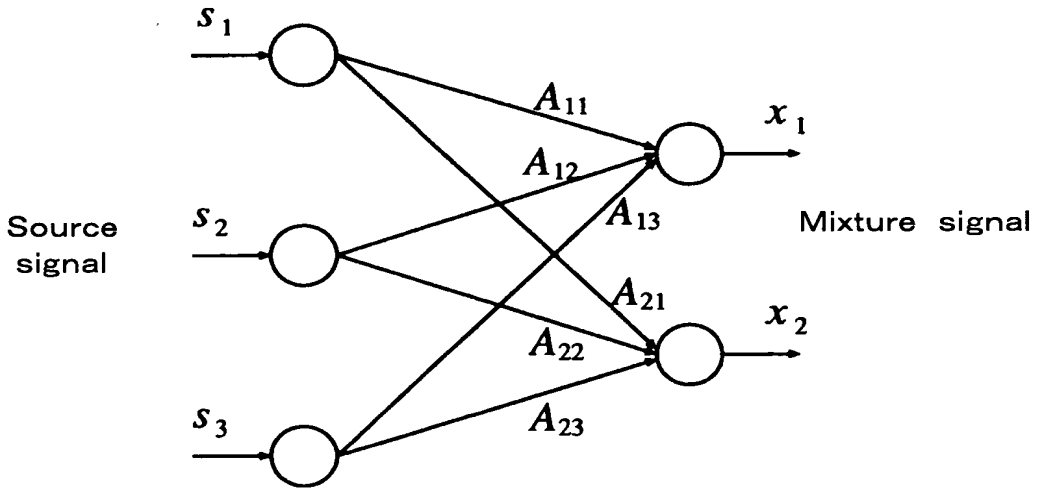
s1
s2
s3
Source signal
A11
A12
A13
A21
A22
A23
x1
x2
Mixture signal

Fig. 6

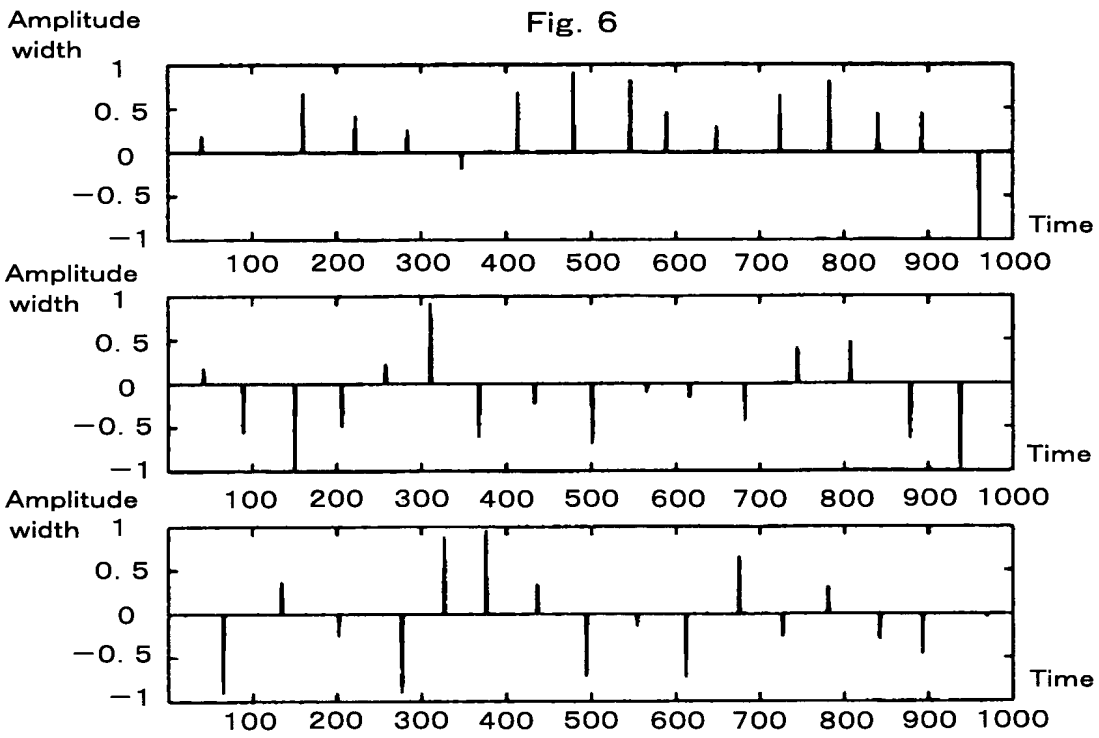
Amplitude width
1
0. 5
0
−0. 5
−1
Time
100 200 300 400 500 600 700 800 900 1000
Amplitude width
1
0. 5
0
−0. 5
−1
Time
100 200 300 400 500 600 700 800 900 1000
Amplitude width
1
0. 5
0
−0. 5
−1
Time
100 200 300 400 500 600 700 800 900 1000

Fig. 7

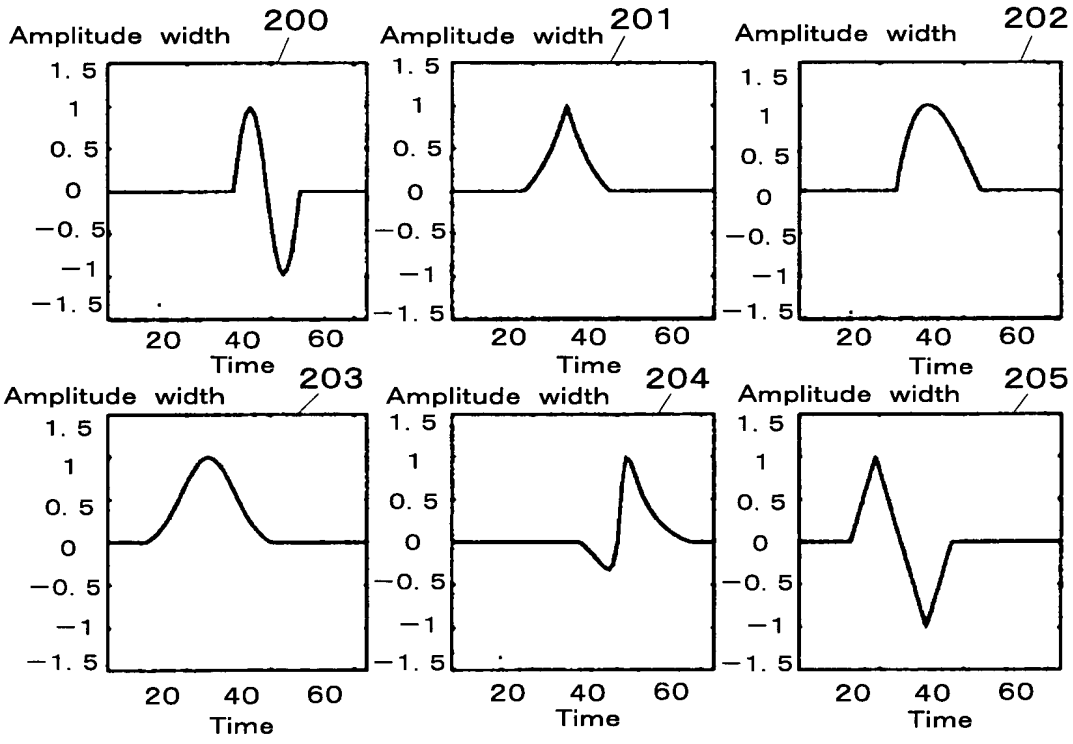
Amplitude width
200
1. 5
1
0. 5
0
−0. 5
−1
−1. 5
20 40 60
Time
Amplitude width
201
1. 5
1
0. 5
0
−0. 5
−1
−1. 5
20 40 60
Time
Amplitude width
202
1. 5
1
0. 5
0
−0. 5
−1
−1. 5
20 40 60
Time
Amplitude width
203
1. 5
1
0. 5
0
−0. 5
−1
−1. 5
20 40 60
Time
Amplitude width
204
1. 5
1
0. 5
0
−0. 5
−1
−1. 5
20 40 60
Time
Amplitude width
205
1. 5
1
0. 5
0
−0. 5
−1
−1. 5
20 40 60
Time

Fig. 8

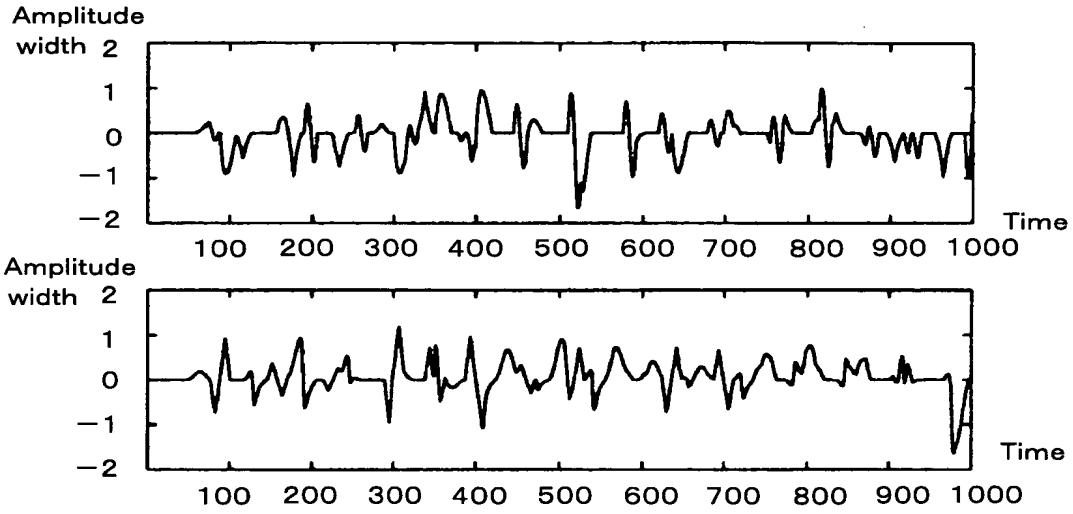
Amplitude
width 2
1
0
−1
−2
Time
100 200 300 400 500 600 700 800 900 1000
Amplitude
width 2
1
0
−1
−2
Time
100 200 300 400 500 600 700 800 900 1000

Fig. 9

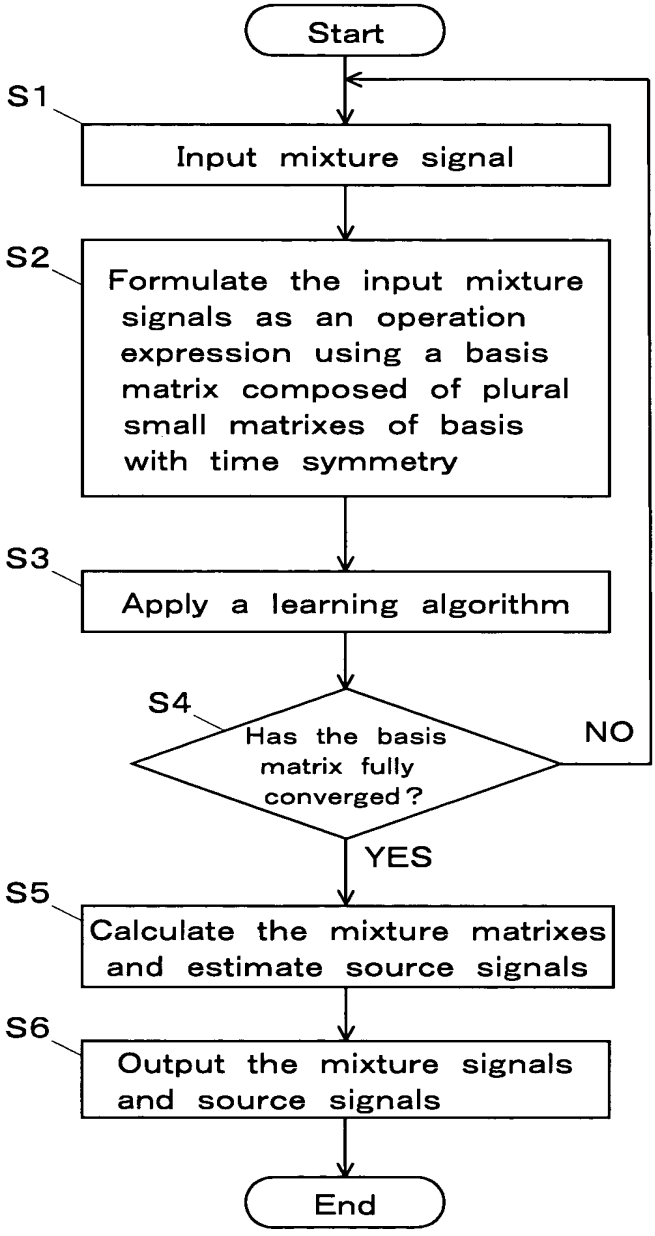
Start
S1
Input mixture signal
S2
Formulate the input mixture signals as an operation expression using a basis matrix composed of plural small matrixes of basis with time symmetry
S3
Apply a learning algorithm
S4
Has the basis matrix fully converged?
NO
YES
S5
Calculate the mixture matrixes and estimate source signals
S6
Output the mixture signals and source signals
End

Fig. 10

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} \begin{bmatrix} A_{11} \end{bmatrix} \begin{bmatrix} A_{12} \end{bmatrix} \begin{bmatrix} A_{13} \end{bmatrix} \\ \begin{bmatrix} A_{21} \end{bmatrix} \begin{bmatrix} A_{22} \end{bmatrix} \begin{bmatrix} A_{23} \end{bmatrix} \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}$$

$$\Downarrow$$

$$\begin{bmatrix} A \end{bmatrix}$$

Fig. 11

$$\begin{bmatrix} A_{ij} \end{bmatrix} = \begin{bmatrix} A_{ij}(31) & \cdots & A_{ij}(0) & \cdots & A_{ij}(-31) & & \\ \ddots & \ddots & \ddots & \vdots & \ddots & & \\ & A_{ij}(31) & \ddots & A_{ij}(0) & \ddots & A_{ij}(-31) & \\ & & \ddots & \vdots & \ddots & \ddots & \ddots \\ & & & A_{ij}(31) & \cdots & A_{ij}(0) & \cdots & A_{ij}(-31) \end{bmatrix}$$

Fig. 12

$$\begin{bmatrix} s_j \end{bmatrix} = \begin{bmatrix} s_j(-62) \\ \vdots \\ s_j(0) \\ \vdots \\ s_j(62) \end{bmatrix}$$

Fig. 13

$$\left[A_{ij} \right] = \begin{bmatrix} A_{ij}(31) & \cdots & A_{ij}(0) & \cdots & A_{ij}(-31) & & \\ & \ddots & \ddots & \ddots & \vdots & \ddots & \\ & & A_{ij}(31) & \ddots & A_{ij}(0) & \ddots & A_{ij}(-31) \\ & & & \ddots & \vdots & \ddots & \ddots & \ddots \\ & & & & A_{ij}(31) & \cdots & A_{ij}(0) & \cdots & A_{ij}(-31) \end{bmatrix}$$

Fig. 14

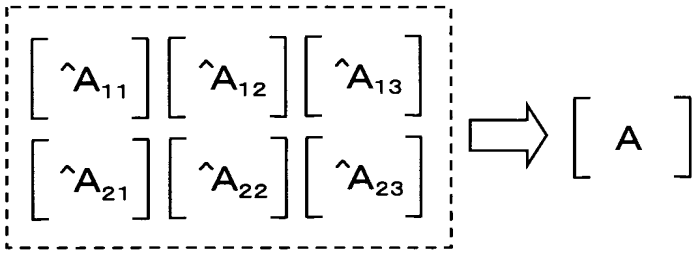

Fig. 15

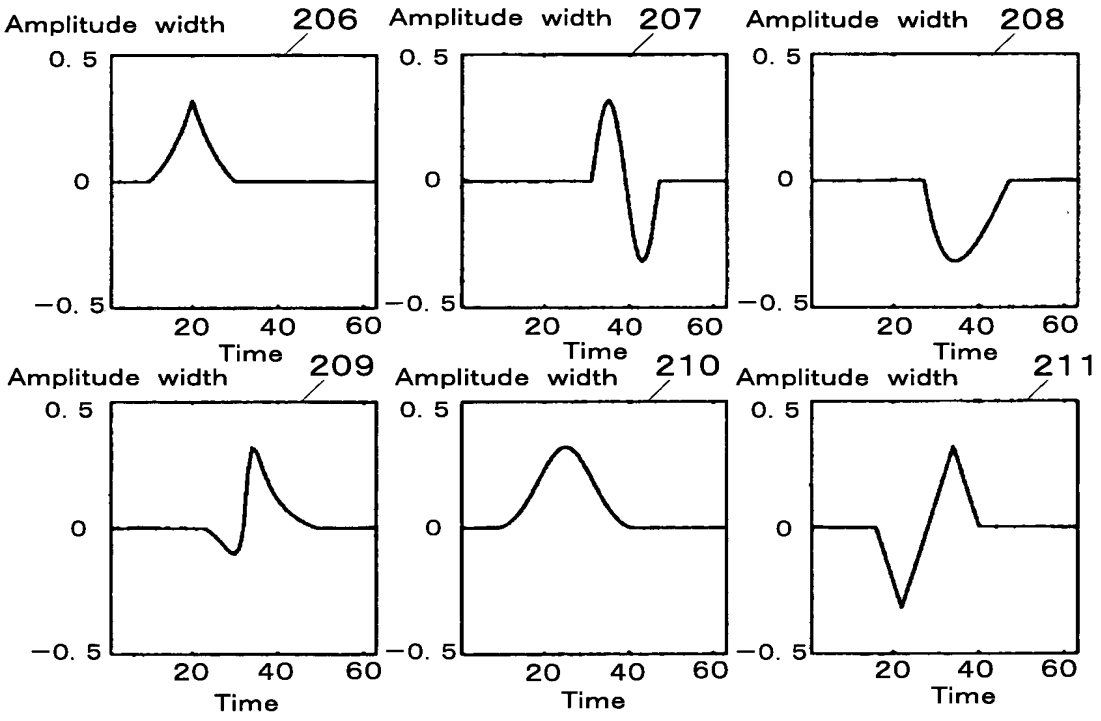
Amplitude width
206
0. 5
0
−0. 5
20
40
60
Time
Amplitude width
207
0. 5
0
−0. 5
20
40
60
Time
Amplitude width
208
0. 5
0
−0. 5
20
40
60
Time
Amplitude width
209
0. 5
0
−0. 5
20
40
60
Time
Amplitude width
210
0. 5
0
−0. 5
20
40
60
Time
Amplitude width
211
0. 5
0
−0. 5
20
40
60
Time

Fig. 16

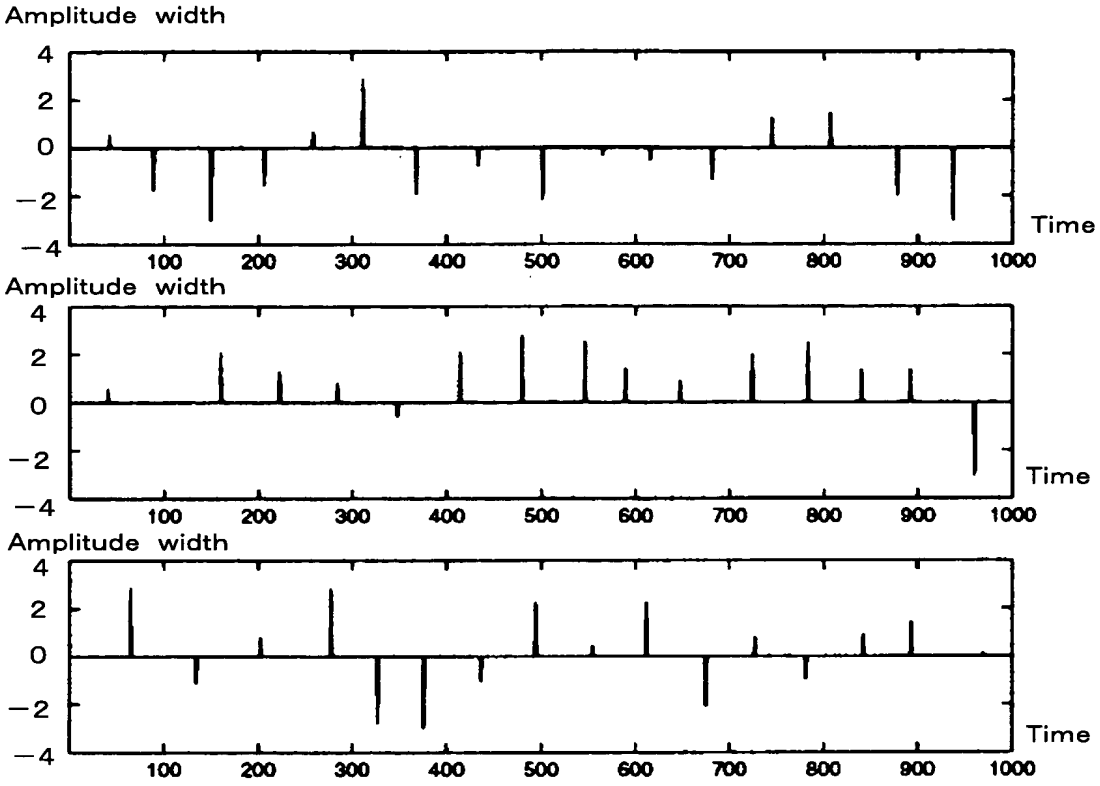

Fig. 17

	$s_1(t)$	$s_2(t)$	$s_3(t)$
Estimated signal 1	-0.0184	0.9965	-0.0095
Estimated signal 2	0.9985	-0.0186	0.0058
Estimated signal 3	-0.0051	0.0099	-0.9976

Fig. 18

$$\begin{bmatrix} x(-q) \\ \vdots \\ x(0) \\ \vdots \\ x(q) \end{bmatrix} = \begin{bmatrix} \\ A \\ \\ \end{bmatrix} \begin{bmatrix} s(-2q) \\ \vdots \\ \vdots \\ s(0) \\ \vdots \\ \vdots \\ s(2q) \end{bmatrix} \quad \text{(formula 12)}$$

$$\begin{bmatrix} A(q) & \cdots A(0) & \cdots A(-q) & & \\ \ddots & \ddots & \ddots & \vdots & \ddots \\ & A(q) & \ddots A(0) & \ddots A(-q) & \\ & \ddots & \vdots & \ddots & \ddots & \ddots \\ & & A(q) & \cdots A(0) & \cdots A(-q) \end{bmatrix} \quad \text{(formula 13)}$$

Fig. 19

$$\begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix} = \begin{bmatrix} A_{11} \end{bmatrix} \cdots \begin{bmatrix} A_{1n} \end{bmatrix} \begin{bmatrix} s_1 \\ \vdots \\ s_n \end{bmatrix}$$

$$\vdots \quad \vdots \quad \ddots \quad \vdots$$

$$\begin{bmatrix} A_{m1} \end{bmatrix} \cdots \begin{bmatrix} A_{mn} \end{bmatrix}$$

(formula 14)

Fig. 20

$$[A] = \begin{bmatrix} A_{11} \end{bmatrix} \cdots \begin{bmatrix} A_{1n} \end{bmatrix}$$

$$\vdots \quad \ddots \quad \vdots$$

$$\begin{bmatrix} A_{m1} \end{bmatrix} \cdots \begin{bmatrix} A_{mn} \end{bmatrix}$$

Fig. 21

$$\left[A_{ij}\right]=\begin{bmatrix} A_{ij}(q) & \cdots & A_{ij}(0) & \cdots & A_{ij}(-q) & & \\ & \ddots & \ddots & \ddots & \vdots & \ddots & \\ & & A_{ij}(q) & \ddots & A_{ij}(0) & \ddots & A_{ij}(-q) \\ & & & \ddots & \vdots & \ddots & \ddots \\ & & & & A_{ij}(q) & \cdots & A_{ij}(0) & \cdots & A_{ij}(-q) \end{bmatrix}$$